MR. BALFOUR ON SCIENTIFIC PROGRESS.[1]

APART altogether from individual likes and dislikes, is there any characteristic note which distinguishes this century from any that have gone before it?

On this point I range myself with those who find the characteristic note in the growth of science. In the last 100 years the world has seen great wars, great national and social upheavals, great religious movements, great economic changes. Literature and art have had their triumphs, and have permanently enriched the intellectual inheritance of our race. Yet, large as is the space which subjects like these legitimately fill in our thoughts, much as they will occupy the future historian, it is not among these that I seek for the most important and the most fundamental differences which separate the present from preceding ages. Rather is this to be found in the cumulative products of scientific research, to which no other period offers a precedent or a parallel. No single discovery, it may be, can be compared in its results to that of Copernicus; no single discoverer can be compared in genius to Newton; but, in their total effects, the advances made by the nineteenth century are not to be matched. Not only is the surprising increase of knowledge new, but the use to which it has been put is new also. The growth of industrial invention is not a fact we are permitted to forget. We do, however, sometimes forget how much of it is due to a close connection between theoretical knowledge and its utilitarian application which, in its degree, is altogether unexampled in the history of mankind. I suppose that, at this moment, if we were allowed a vision of the embryonic forces which are predestined most potently to affect the future of mankind, we should have to look for them, not in the Legislature, nor in the Press, nor on the platform, nor in the schemes of practical statesmen, nor the dreams of political theorists, but in the laboratories of scientific students whose names are but little in the mouths of men, who cannot themselves forecast the results of their own labours, and whose theories could scarce be understood by those whom they will chiefly benefit.

I do not propose to attempt any sketch of our gains from this most fruitful union between science and invention. I may, however, permit myself one parenthetic remark on an aspect of it which is likely more and more to thrust itself unpleasantly upon our attention. Marvellous as is the variety and ingenuity of modern industrial methods, they almost all depend in the last resort upon our supply of useful power; and our supply of useful power is principally provided for us by methods which, so far as I can see, have altered not at all in principle, and strangely little in detail, since the days of Watt. Coal, as we all know, is the chief reservoir of energy from which the world at present draws, and from which we in this country must always draw; but our main contrivance for utilising it is the steam engine, and, by its essential nature, the steam engine is extravagantly wasteful. So that, when we are told, as if it was something to be proud of, that this is the age of steam, we may admit the fact, but can hardly share the satisfaction. Our coalfields, as we know too well, are limited. We certainly cannot increase them. The boldest legislator would hesitate to limit their employment for purposes of domestic industry. So the only possible alternative is to economise our method of consuming them. And for this there would, indeed, seem to be a sufficiency of room. Let a second Watt arise. Let him bring into general use some mode of extracting energy from fuel which shall only waste eighty per cent. of it, and lo! your coalfields, as sources of power, are doubled at once. The hope seems a modest one, but it is not yet fulfilled; and therefore it is that we must qualify the satisfaction with which at the end of the century we contemplate the unbroken course of its industrial triumphs. We have, in truth, been little better than brilliant spendthrifts. Every new invention seems to throw a new strain upon the vast, but not illimitable, resources of nature. Lord Kelvin is disquieted about our supply of oxygen; Sir William Crookes about our supply of nitrates. The problem of our coal supply is always with us. Sooner or later the stored-up resources of the world will be exhausted. Humanity, having used or squandered its capital, will thenceforward have to depend upon such current income as can be derived from that diurnal heat of the sun and the rotation of the earth till, in the sequence of the ages, these also begin to fail. With such remote speculations we are not now concerned. It is enough for us to take note how rapidly the prodigious progress of recent discovery has increased the drain upon the natural wealth of old manufacturing countries, and especially of Great Britain, and, at the same time, frankly to recognise that it is only by new inventions that the collateral evils of old inventions can be mitigated; that to go back is impossible; that our only hope lies in a further advance.

After all, however, it is not necessarily the material and obvious results of scientific discoveries which are of the deepest interest. They have effected changes more subtle and perhaps less obvious which are at least as worthy of our consideration and are at least as unique in the history of the civilised world. No century has seen so great a change in our intellectual apprehension of the world in which we live. Our whole point of view has changed. The mental framework in which we arrange the separate facts in the world of men and things is quite a new framework. The spectacle of the universe presents itself now in a wholly changed perspective. We not only see more, but we see differently. The discoveries in physics and in chemistry, which have borne their share in thus re-creating for us the evolution of the past, are in process of giving us quite new ideas as to the inner nature of that material whole of which the world's traversing space is but an insignificant part. Differences of quality once thought ultimate are constantly being resolved into differences of motion or configuration. What were once regarded as things are now known to be movement. Phenomena apparently so wide apart as light, radiant heat and electricity, are, as it is unnecessary to remind you, now recognised as substantially identical. From the arrangement of atoms in the molecule, not less than their intrinsic nature, flow the characteristic attributes of the compound. The atom itself has been pulverised, and speculation is forced to admit as a possibility that even the chemical elements themselves may be no more than varieties of a single substance. Plausible attempts have been made to reduce the physical universe, with its infinite variety, its glory of colour and of form, its significance and its sublimity, to one homogeneous medium in which there are no distinctions to be discovered but distinction of movement or of stress. And although no such hypothesis can, I suppose, be yet accepted, the gropings of physicists after this, or some other not less audacious unification, must finally, I think, be crowned with success. The change of view which I have endeavoured to indicate is purely scientific, but its consequences cannot be confined to science. How will they manifest themselves in other regions of human activity, in literature, in art, religion? The subject is one rather for the lecturer on the twentieth century than for the lecturer on the nineteenth. I, at least, cannot endeavour to grapple with it.

[1] Address delivered by Mr. Balfour, M.P., at the opening of the Cambridge Summer Meeting on August 2. Abridged from the *Times*.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 14.—"The Electrical Effects of Light upon Green Leaves." By Augustus D. Waller, M.D., F.R.S.

In the preliminary communication recently made to the Royal Society, the author shows how, from the study of the electrical effects of light upon the retina, he was led to ask whether the chemical changes aroused by the action of light upon green leaves are also accompanied by electrical effects demonstrable in the same way as the eye currents. The question is tested in the following way:—A young leaf freshly gathered is laid upon a glass plate and connected with a galvanometer by means of two unpolarisable clay electrodes A and B. The half of the leaf connected with A is shaded by a piece of black paper. An inverted glass jar forms a moist chamber to leaf and electrodes, which are then enclosed in a box provided with a shuttered aperture through which light can be directed. A water trough in the path of the light serves to cut out heat more or less. Under favourable conditions there is obtained with such an arrangement a true electrical response to light, consisting in the establishment of a potential difference between illuminated and non-illuminated half of a leaf, amounting to 0·02 volt.

The deflection of the galvanometer spot during illumination is such as to indicate current in the leaf from excited to protected part. The deflection begins and ends sharply with the beginning and end of illumination; it is provoked slightly by diffuse